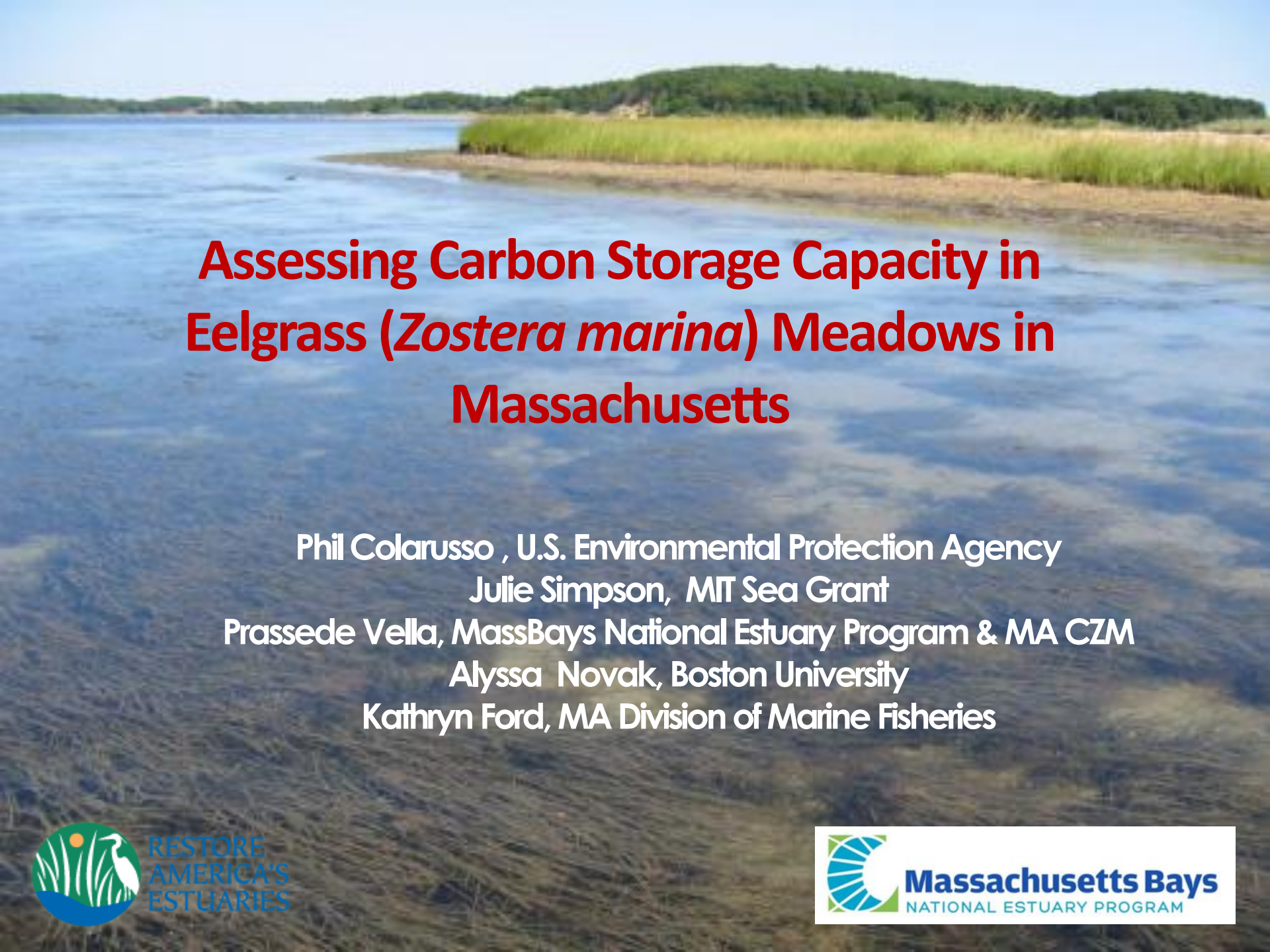


Assessing Carbon Storage Capacity in Eelgrass (*Zostera marina*) Meadows in Massachusetts

Phil Colarusso , U.S. Environmental Protection Agency
Julie Simpson, MIT Sea Grant
Prassede Vella, MassBays National Estuary Program & MA CZM
Alyssa Novak, Boston University
Kathryn Ford, MA Division of Marine Fisheries

RESTORE AMERICA'S ESTUARIES

Massachusetts Bays NATIONAL ESTUARY PROGRAM

Objectives

- To quantify the carbon storage potential of *Zostera marina* in Massachusetts and the Gulf of Maine.
- To further understand the carbon sequestration potential of eelgrass.
- To raise awareness among decisionmakers on the mitigating role of aquatic habitats to climate change impacts.
- To help build the case for conservation and restoration of this vital marine ecosystem.

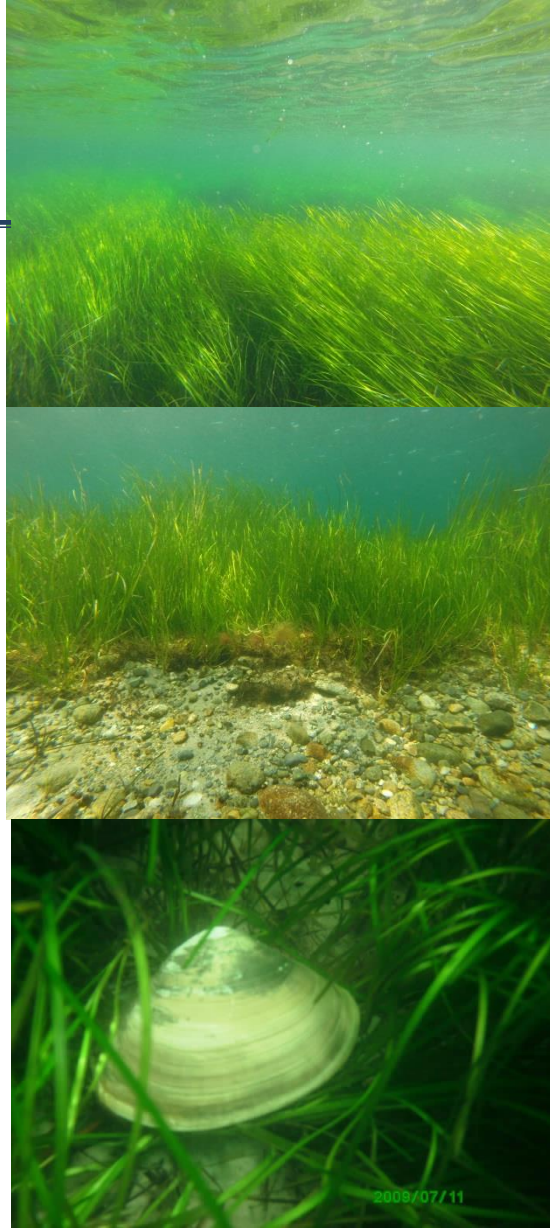
Eelgrass (*Zostera marina*)

Characteristics:

- Single, dominant species in meadows
- Cool water species (<25˚C)
- Wave-sheltered habitat
- Soft bottom
- Water clarity, good light conditions
- Shallow waters (6-10m)

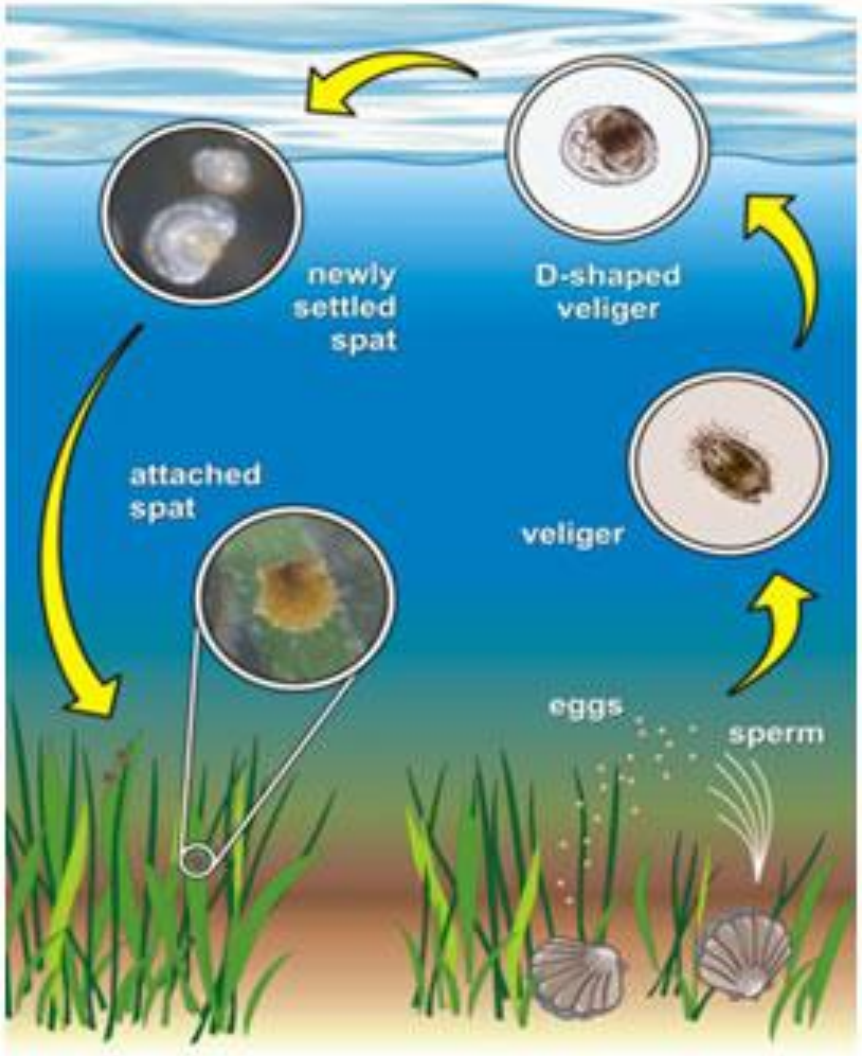
Importance :

- Critical habitat for other species
- Protection from waves and storm surge
- Carbon capture and storage



Critical habitat for other species:

- many commercially important fish (e.g. cod, tautog, winter flounder)
- hard clams
- bay scallops (juveniles) - $2.5 million/year in MA alone (2014)

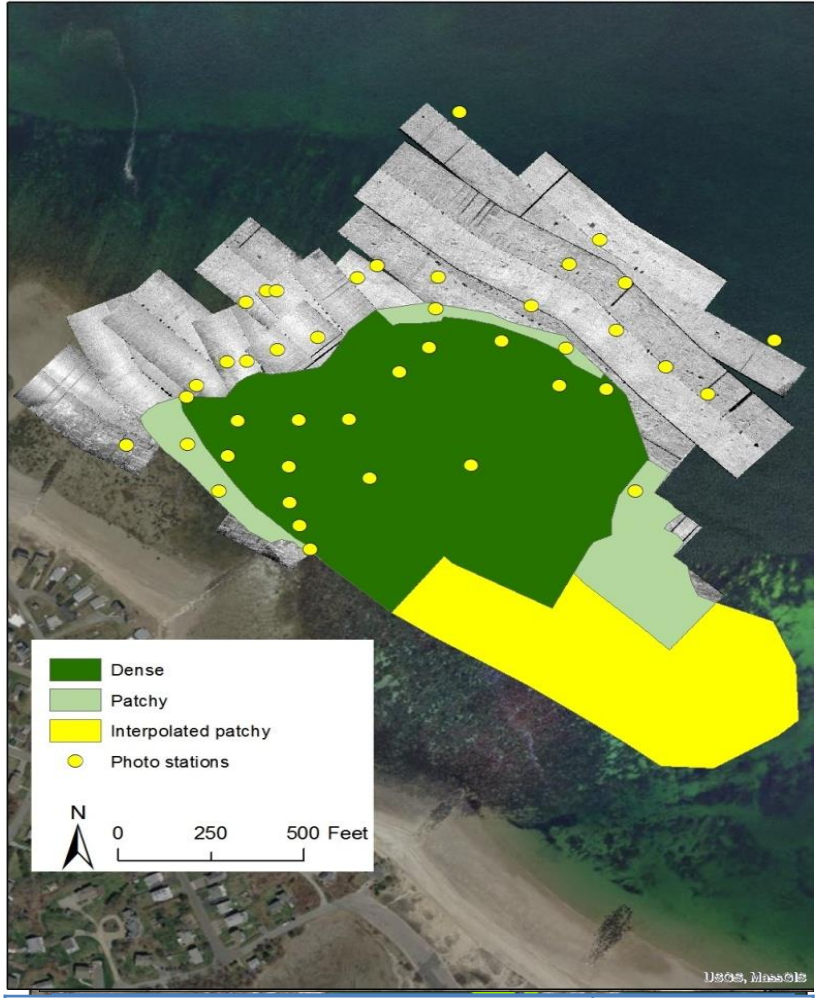


Eelgrass challenges

1. Knowing what's there
2. Protecting what's there
3. Restoring what isn't there any more

1. How much eelgrass is there?

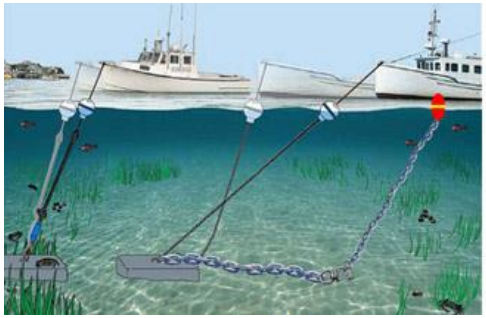
- Mapping (aerial, diving, acoustics)
- This project:
  - August 2015, daytime,
  - Photos and acoustics
- Examples: Cohasset, Sandwich
- Categorized eelgrass: dense, patch
- Interpolated with previous data to refine areal coverage



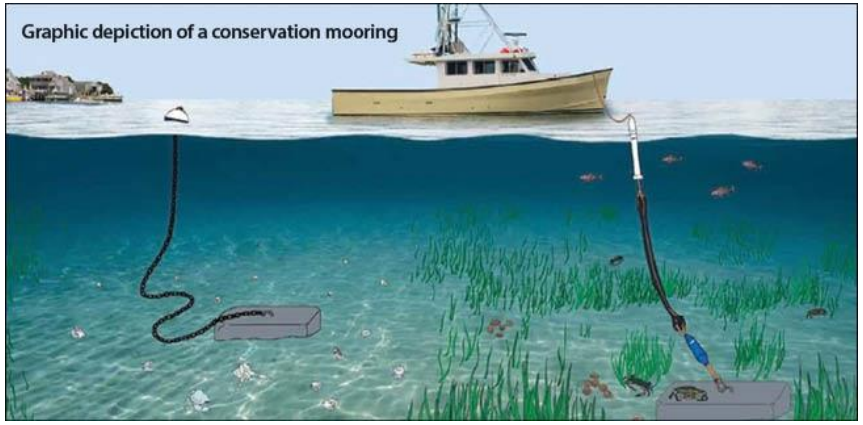
Dense eelgrass	17.1 ac
Patchy eelgrass	4 ac
Interpolated from aerial	8.3 ac
Total	29.4 ac

2. Protecting what's there:

Boat moorings cause a lot of damage!

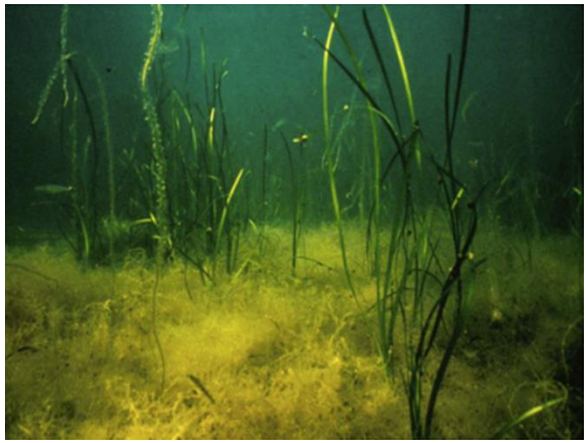


Using conservation moorings



Water quality: the Goldilocks principle of nitrogen

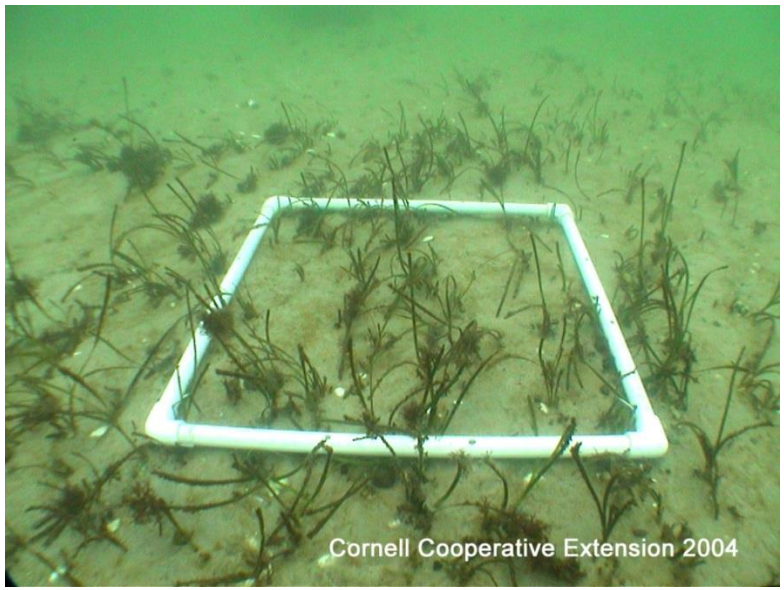
Just enough



Too much!!!

3. Eelgrass restoration:

Expensive, laborious, various levels of success



Carbon capture and storage by eelgrass

- May store 2-4x more carbon than tropical forests
- < 0.5% of the global ocean area, but accounts for > 50% of carbon storage
- Seagrass meadows not as well characterized as intertidal habitats
- No data from North America north of Chesapeake Bay

Table 1 | Summary of collected data on seagrass biomass and soil properties from the global data set.

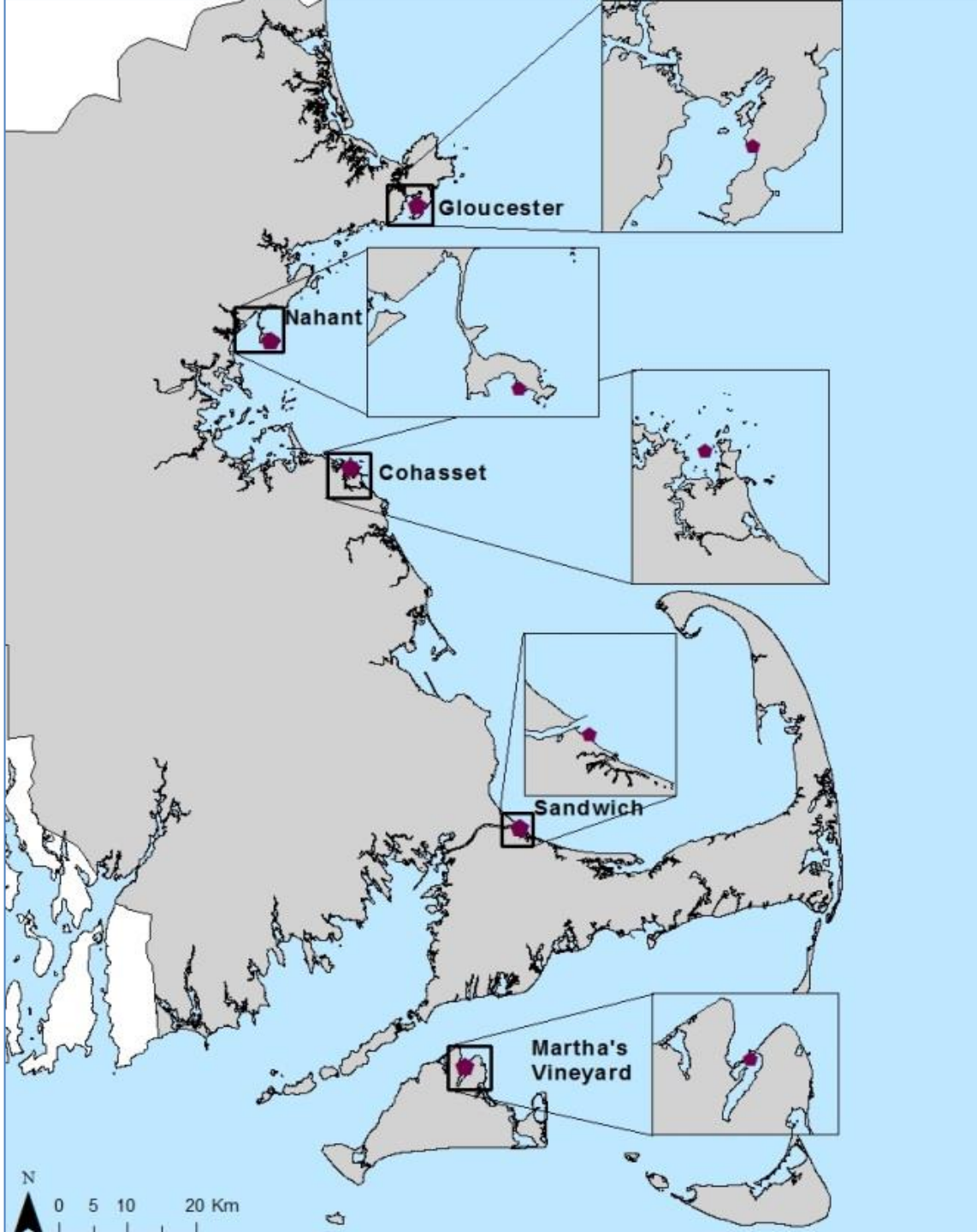
	n	Range	Median	Mean ± 95% CI
Above-ground biomass (Mg (C_{org}) ha^{-1})	251	0.001-5.548	0.264	0.755 ± 0.128
Below-ground biomass (Mg (C_{org}) ha^{-1})	251	0.001-17.835	0.540	1.756 ± 0.375
Total seagrass biomass (Mg (C_{org}) ha^{-1})	251	0.001-23.382	1.000	2.514 ± 0.489
Soil C_{org} (percentage of dry weight)	2,535	0-48.2	1.8	2.5 ± 0.1
	3,561	0-48.2	1.4	2.0 ± 0.1
DBD (g (dry weight) ml^{-1})	2,484	0.06-2.35	0.92	1.03 ± 0.02

Values in bold include estimates based on statistical relationships with other variables.

Forqurean et al. 2012

Field survey

- 5 sites in Massachusetts along the coast
- Along a gradient of wave exposure and fetch
- July – August 2015 (peak growth)



Sampling methods
(Short & Coles, 2001)

- Eelgrass bed morphology:
  10 random quadrats (0.0625 m^2) = shoot density, canopy height, leaf area index, # of reproductive shoots
  20 random shoots per depth zone for laboratory analysis

- Sediment sampling:
  3 cores/ depth zone
  3 reference cores
  30-cm deep cores (approx.)

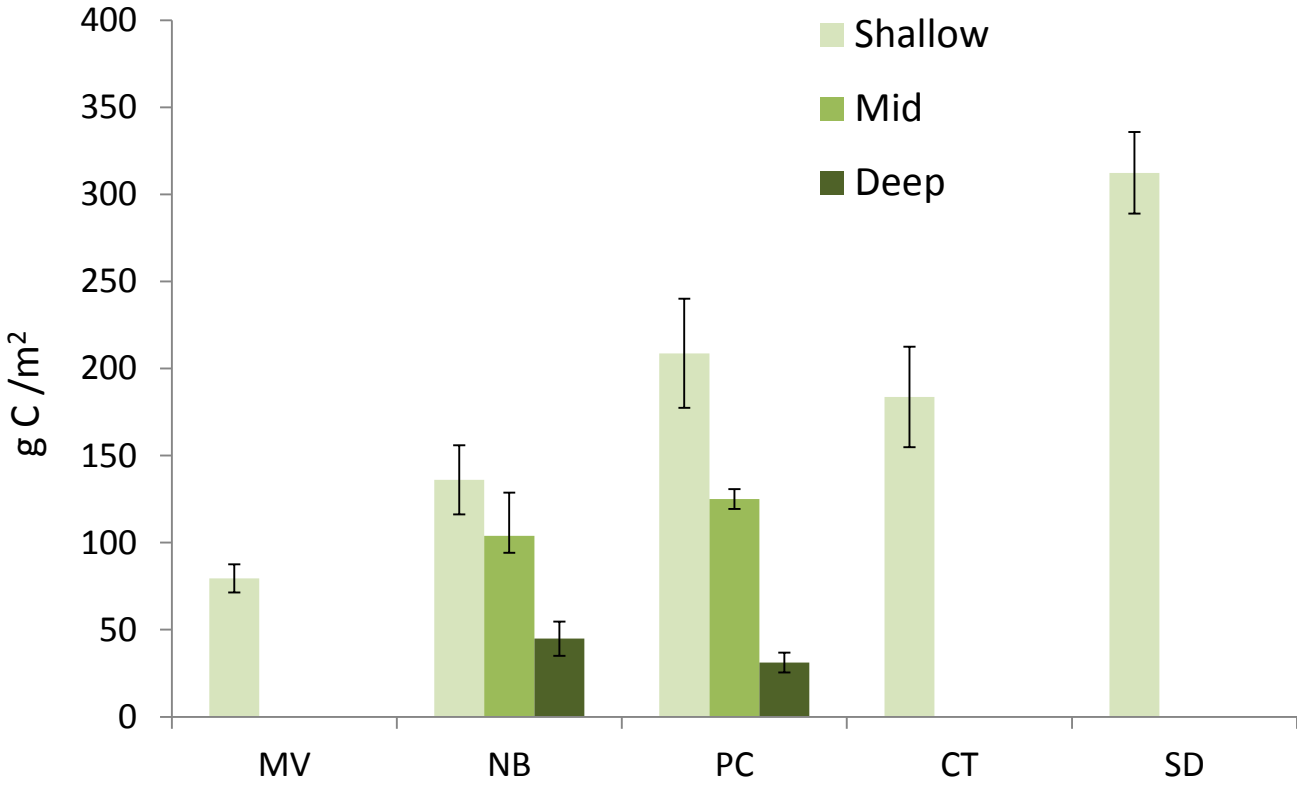
- Eelgrass bed mapping using acoustics and photography

Lab analyses

- Above-ground and below-ground biomass
- Sediment bulk density
- % organic matter by LOI
- Stable Isotopes (^{13}C, ^{15}N , %C, %N) - sediment cores and plant material

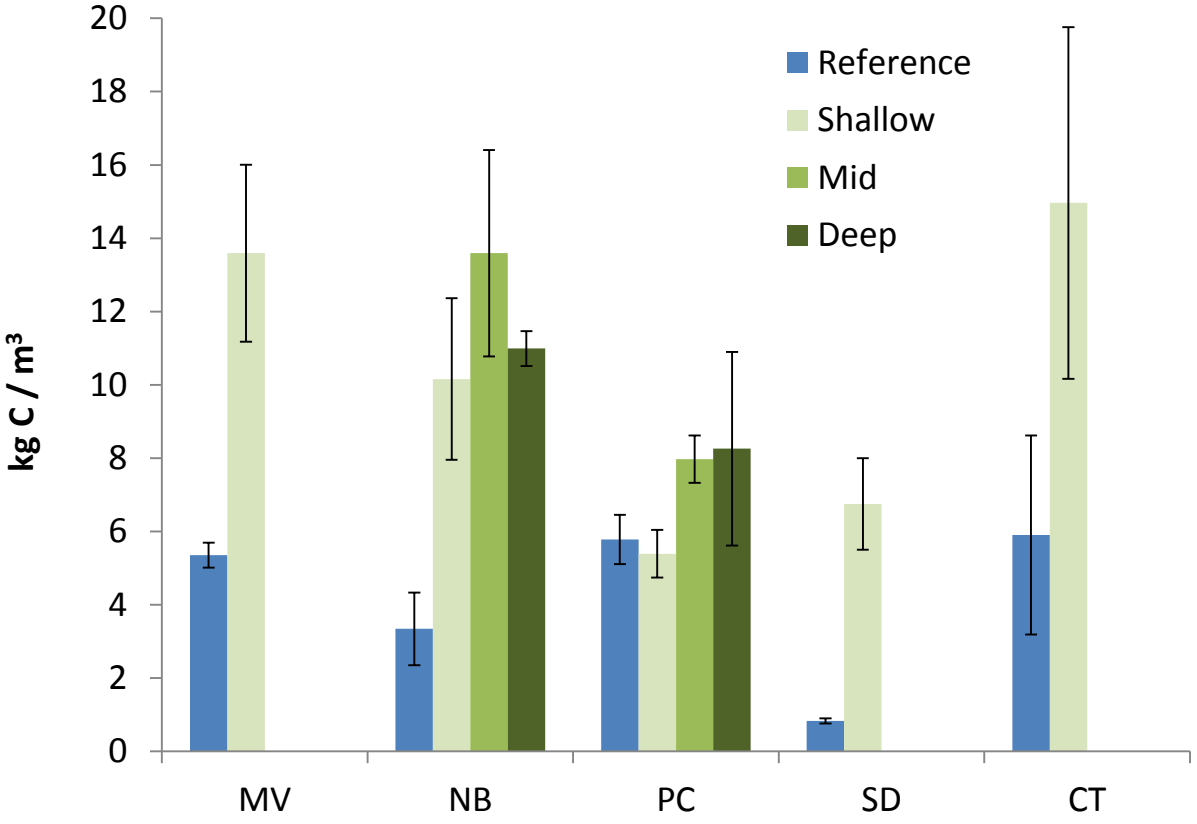
Preliminary data: above-ground carbon

- Standing carbon stocks in plant tissue are greatest up to 4m depth and decrease in deeper waters
- Nutrient supply likely plays a strong role in carbon captured in above-ground shoots

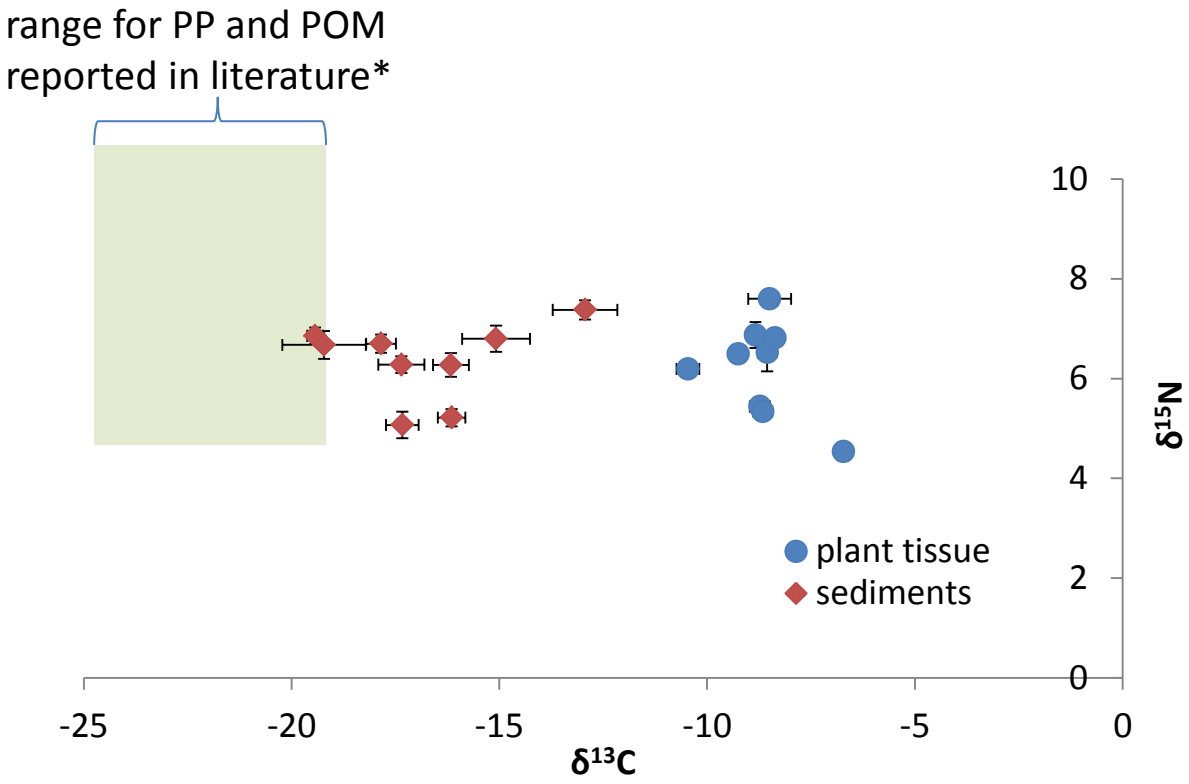


Preliminary data: below-ground carbon

- Sediment carbon was generally higher within beds than in reference sites.
- Sediment carbon increased with depth in general.



What is the source of the sediment carbon?



*Oczkowski et al., 2014;
Fry & Wainbright, 1991

- Stable isotope results do not point at plant tissue or phytoplankton/ POM as an obvious source.
- Carbon in the sediments within the eelgrass beds represents a combination of these two likely sources.
- Stored carbon is sequestered through fixation and collection of organic matter from the water column.

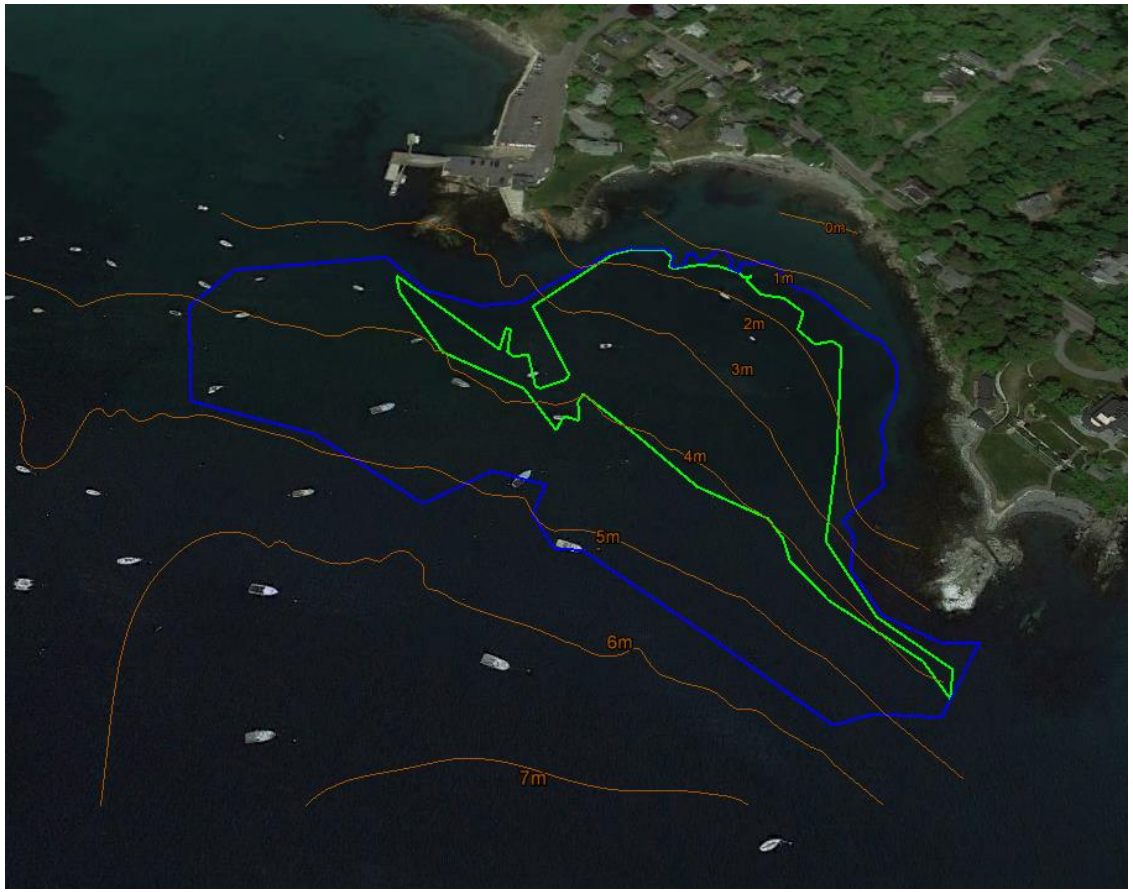
How do our meadows compare to others studied?

	Living Seagrass Biomass MgC ha^{-1} (mean +/- 95%CI)	Soil C_{org} MgC ha^{-1} (mean +/- 95%CI)
North Atlantic	0.85 +/- 0.19	48.7 +/- 14.5
Global Average	2.51 +/- 0.49	194.2 +/- 20.2
2015 study	0.25 – 3.0	12.0 – 50.0

Data from Fourqurean et al. 2012

- Sediment carbon levels are similar to other North Atlantic studies but substantially lower than global average.

How much carbon is stored in a healthy eelgrass meadow?



Eelgrass bed in Nahant (J. Simpson)

- 727 g C/m^2 or 123,104 kg C in whole meadow
- Carbon equivalent to 357 human bodies (dry wt) or burning of 57,257 gallons of gasoline

Preliminary conclusions

- Eelgrass meadows in the Northeast sequester substantial quantities of carbon, comparable to or exceeding other values reported from the North Atlantic.

- Carbon is sequestered through both fixation and storage. Stable isotope values suggest carbon stored in sediments does not originate solely from eelgrass, but comes from a mix of phytoplankton and particulate organic matter.

- Sea level rise is rapid in the Northeast and opportunities for inland migration are limited. SLR may reduce this valuable carbon storage capacity in the future.

Lessons learnt and next steps

- Research continues (expand to GOM)
- Survey was repeated in 2016: 8 sites & refined the methodology; currently conducting data analysis.
- Sampling to expand in 2017
- Explore management implications
  - Increased ecosystem value – increased restoration and protection efforts
  - Climate change – protection/mitigation of impacts especially SLR and storms; eelgrass migration???
  - Carbon market – what do our numbers represent? Do we have enough eelgrass? etc

Thank you

Prassede.vella@state.ma.us

First slide photo: SeagrassNet .org (Hog Island, Pleasant Bay)

Does carbon concentration change with depth in sediment?